CYTOLOGICAL STUDIES IN ULMACEAE, MORACEAE, AND URTICACEAE

P. N. MEHRA AND B. S. GILL

THE FAMILY URTICACEAE, which embraces 42 genera and 600 species of herbs, shrubs, and trees (Lawrence, 1951), is not of any great importance to forestry, but Moraceae and Ulmaceae, which include respectively 15 genera with 150 species and 73 genera with over 1000 species (Lawrence, l.c.), produce valuable timbers like *Piratinera guianensis* Aublet, *Distemonanthus benthamianus* Baillon, species of *Morus* L. and *Artocarpus* Forster (Moraceae), and species of *Celtis* L. and *Ulmus* L. (Ulmaceae). In addition, rubber (*Castilloa elastica* Cerv. and *Ficus elastica* Roxb.), paper (*Broussonetia papyrifera* (L.)Vent. and species of *Streblus* Lour.), dye (*Chlorophora tinctoria* D. Don), etc. are commercially valuable products obtained from Moraceae. In India, nine species of Moraceae, four of Ulmaceae, and one of Urticaceae are recognized as commercial timbers (Pearson & Brown, 1932).

For any rational tree breeding program, comprehensive data pertaining to chromosome number, polyploidy, and aneuploidy in the desired genera, in addition to knowledge of meiotic behavior and variability, are essential. Cytological studies were, therefore, undertaken on the members of Ulmaceae, Moraceae, and Urticaceae from the Western Himalayas as a part of the project on the cytological investigations of the Himalayan hardwoods which we have been carrying on for some years.

MATERIAL AND METHODS

Meiotic studies were made from floral buds fixed in Carnoy's fluid and squashed in 1 per cent acetocarmine. Use of glacial acetic acid saturated with iron acetate in the fixative greatly improved the stainability of the chromosomes. For mitotic studies, young leaf tips and root tips were pretreated with 0.003 M solution of 8-hydroxyquinoline for 3 hours at about 20°C, hydrolyzed in acetolacmoid and N:HCl (9:1), and finally squashed in acetolacmoid. Slides were made permanent in Euparal.

Figures were made at a uniform magnification of 1350 ×. The voucher specimens have been deposited in the Herbarium, Department of Botany, Panjab University, Chandigarh, India.

OBSERVATIONS

Cytological studies were carried out on the material collected mostly from wild populations from the Mussoorie, Nainital, and Simla hills in the

TABLE 1. **Chromosome numbers of woody species in the Ulmaceae, Moraceae, and Urticaceae** (*continued*).

TAXA	LOCALITY (with altitude in meters)	FLOWERING AND FRUITING PERIODS	CHROMOSOME NUMBER	FIGURE NUMBER	PREVIOUS REPORTS
**Ficus cunia* Buch.-Ham.	Nainital: Dogaon, 1000	4–9	$2n = 26$	13	
†*Streblus asper* Lour.	Nainital: Tanakpur, 450	4–5	$n = 13$		$n = 12$: Mitra & Datta, 1967. $n = 13$: Gajapathy, 1961.
Broussonetia papyrifera (L.) Vent.	Dehra Dun, 400	7–9	$n = 13$	14	$2n = 26$: Bowden, 1940; Hsu, 1967.
	Nainital: Bhimtal, 1300		$n = 13$	15	
URTICACEAE					
**Boehmeria rugulosa* Weddell	Nainital: Ratighat, 1350	7–9	$n = 28$	16	
**B. platyphylla* D. Don	Mussoorie: Jhariapani, 1400	6–9	$n = 14$	17	
	Darjeeling: Tista, 300		$n = 28$	18	
Debregeasia longifolia Weddell (= *D. velutina* Gaud.)	Nainital, 1950	9–11	$n = 14$		$2n = 28$: LeCoq, 1963.
**D. hypoleuca* Weddell	Kasauli: Dharampur, 1200	9–11	$n = 14$	27	

* Species investigated for the first time.

† New cytotypes.

Western Himalayas and adjacent plains, except in the case of *Celtis cinnamomea* and *Boehmeria platyphylla*, which were collected from the Eastern Himalayas. The chromosome numbers of 22 woody species belonging to 11 genera of these three families are given in TABLE 1, along with specific localities of collections, previous reports, and flowering and fruiting seasons. The numerals indicate months of the year. Thus 1 stands for January, 2 for February, and so on.

ULMACEAE

Holoptelea Planchon.

H. integrifolia Planchon.

A large deciduous tree, the only representative of the genus, producing valuable timber. Common in the tropical moist deciduous forests along the foot of the Himalayas and in outer ranges. Abundant in the moist Sal-Bearing forests of the Nainital area. Bark: gray to dark gray, slightly rough, cracked on the old trees.

Twenty-eight chromosomes were counted at mitotic metaphase (FIGURE 4). Meiosis was perfectly normal and 14 bivalents regularly constituted at metaphase-I (FIGURE 5).

Ulmus L.

U. wallichiana Planchon.

A medium- to large-sized deciduous tree and a source of commercial timber. Found in the subtropical and temperate forests of the Western Himalayas between 1000 and 3000 m.; not common in the Nainital hills. Bark: brown, rough, vertically fissured.

The somatic chromosome number was determined as $2n = 28$ (FIGURE 6). The karyotype was asymmetrical. Of the 14 pairs of chromosomes, 11 were acrocentric, two metacentric, and in one pair the primary constriction was not clear.

Celtis L.

C. australis L. var. *australis*.

Trees to 25 m. in height, often with straight cylindrical boles, and providing timber of commercial importance. Growing throughout the Western Himalayas up to 2700 m., often in open forests. Bark: ash-gray to gray, smooth on young but rough on old trunks, often with horizontal streaks. Drupe glabrous to pilose.

The chromosome number, as determined from the leaf-tip mitosis, was $2n = 40$ (FIGURE 19). Fifteen pairs were metacentric and three acrocentric, while a centromere could not be located in the remaining two pairs.

C. australis var. *eriocarpa* Dcne.

A tree up to 15 m. in height. Common in the Nainital hills between 1000 and 1800 m. Bark: light gray, slightly rough, often with horizontal streaks. Drupes pubescent to woolly.

The chromosome number as determined from PMC's was $n = 10$ (FIGURE 20). Meiosis was normal.

C. tetrandra Roxb.

A small to large deciduous tree. Found in the subtropical Himalayas from the Sutlej eastwards to Sikkim, between 1000 and 1500 m. Bark: gray to ash-gray, smooth.

Ten bivalents were invariably counted at diakinesis (FIGURE 21) and metaphase-I.

MORACEAE

Artocarpus Forster.

A. lakoocha Roxb.

A large tree attaining a height of 18 m. in the Himalayas, with short bole and spreading branches. Found in the tropical Himalayas from Kumaon eastwards, chiefly in evergreen forests. Not common in the Kumaon hills. Often planted. Wood of commercial value. Bark: reddish brown, rough (FIGURE 1).

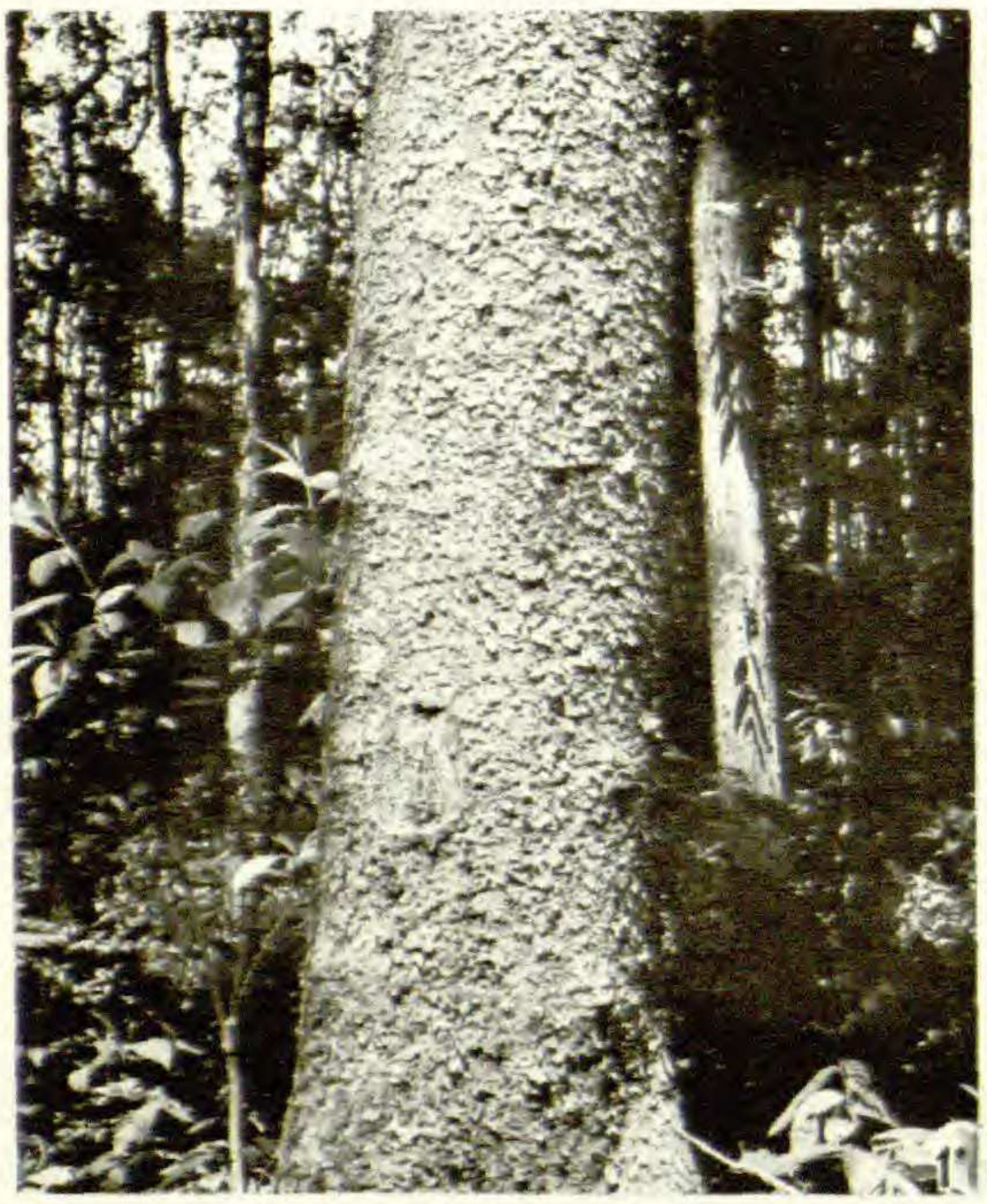


FIGURE 1. *Artocarpus lakoocha*, bark pattern. FIGURE 2. *Morus laevigata*, bark pattern, × 4.

The haploid chromosome number was $n = 28$ (FIGURE 8). The species is tetraploid on the base number $x = 14$. Meiosis was found to be normal and pollen fertility 100 per cent.

Morus L.

M. alba L.

A small to medium-sized deciduous tree producing valuable timber for the sports industry. Occurring wild up to 2000 m. in the outer Himalayan ranges, but often planted for its fruit. Bark: pale brown to grayish brown.

The normal flowering season of the species is February to April, but some individuals at Dehra Dun were observed to be in full bloom in the month of September. Meiosis was perfectly normal with 100 per cent pollen fertility.

Fourteen bivalents were regularly constituted at metaphase-I of which one was conspicuously larger than the rest (FIGURES 9, 22).

M. serrata Roxb.

A medium-sized deciduous tree with spreading branches and short bole. Growing in temperate forests of the Western Himalayas, often along moist and shady ravines, but not very common in the Nainital and Simla hills. Timber of some commercial importance. Bark: reddish brown, rough.

The chromosome number $n = 42$ (FIGURE 23) was observed at metaphase-I in populations worked out from various localities in the Nainital and Simla hills. Meiosis was normal and 42 chromosomes were regularly distributed at A-I (FIGURE 24). Pollen fertility was 100 per cent.

M. laevigata Wallich.

A middle-sized deciduous tree and source of timber. Occurring wild (and also cultivated) in the tropical and subtropical Himalayas, but not common in the Nainital area. Bark: reddish brown, rough or somewhat smooth with conspicuous transversely oriented lenticels (FIGURE 2).

Two cytotypes have been discovered. FIGURE 10 shows a pollen mother cell at metaphase-I with 14 bivalents from populations in the Nainital hills. It is diploid. A tetraploid cytotype was discovered in the Khasia and Jaintia hills which showed $n = 28$ at metaphase-I (FIGURE 25).

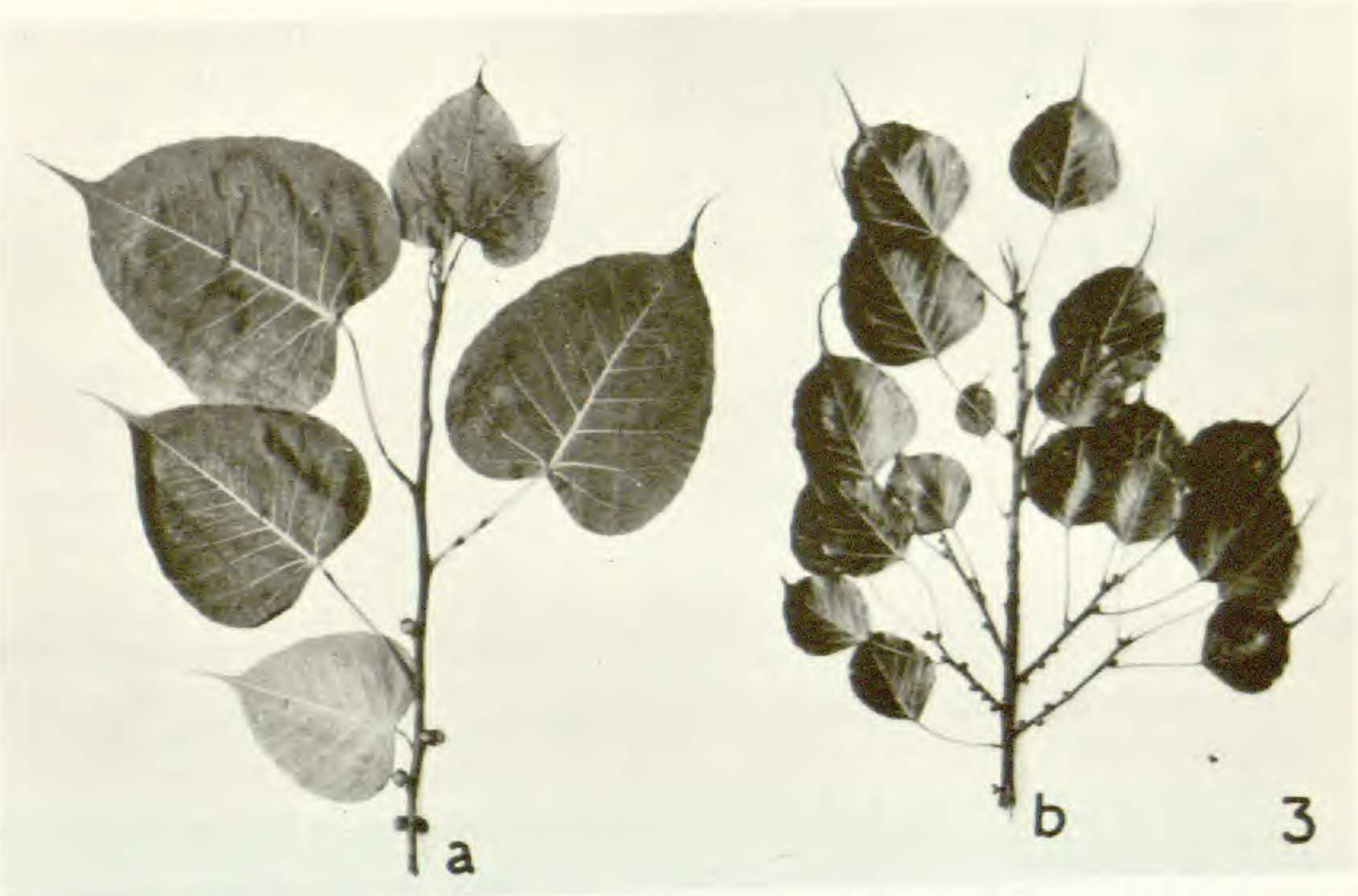


FIGURE 3. *Ficus religiosa*: a, branches of normal form; b, branches of small-leaved form.

The two are distinct morphologically, the tetraploid being larger in all its parts.

Ficus L.

F. religiosa L.

A large deciduous tree with irregular trunk. Occurring wild in the outer and sub-Himalayan ranges up to 1500 m.; also planted. A source of timber of minor commercial importance. Bark: almost smooth, grayish brown, exfoliating in woody scales.

The chromosome number $2n = 26$ was determined from leaf-tip mitosis (FIGURE 11).

Small-leaved form:

This differs from the normal type in having smaller leaves, shorter petiole, fewer lateral veins but relatively longer acumen (FIGURE 3). However, bark character, stomatal size, and number of stomata per unit area are the same in both types. A comparative account of the normal and small-leaved forms is presented in TABLE 2.

TABLE 2. **A comparison of the normal and small-leaved forms of Ficus religiosa.**

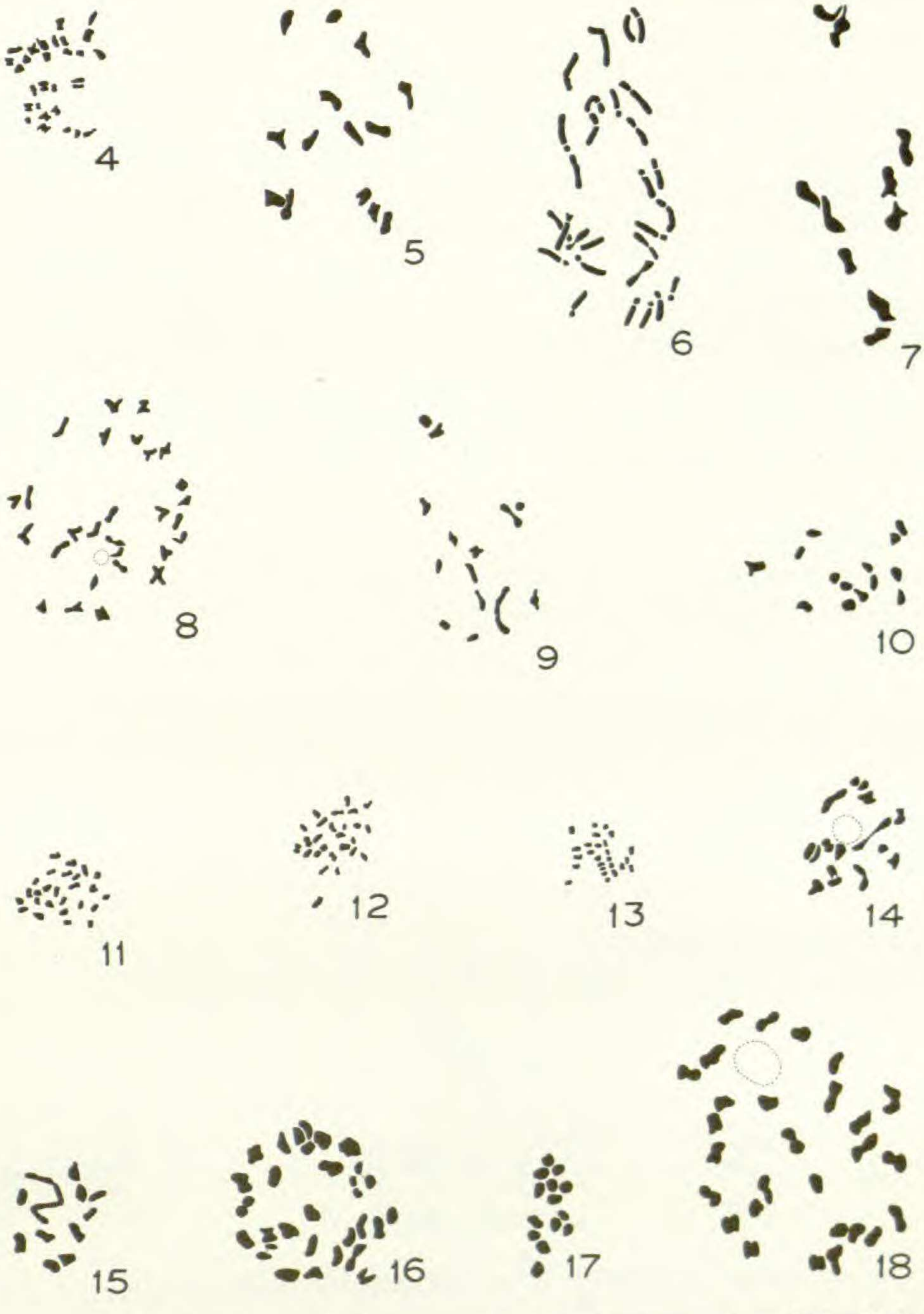
	NORMAL TYPE	SMALL-LEAVED TYPE
HABIT	Large tree.	Large tree.
BARK	Smooth, grayish brown.	Smooth, grayish brown.
LEAVES:		
length	16.0–31.0 cm.	12.5–21.0 cm.
blade size	10.0–21.0 cm. × 8.0–12.0 cm.	8.0–14.0 cm. × 6.0– 8.0 cm.
acumen	3.0– 4.5 cm.	5.0– 6.0 cm.
petiole length	6.0–10.0 cm.	4.5– 7.0 cm.
STOMATA:		
size	35.0–41.0 μm. × 21.0–26.0 μm.	35.0–40.0 μm. × 20.5–26.0 μm.
number per unit area	18.0–20.0	19.0–20.0
DIAMETER OF FIG	0.9– 1.0 cm.	0.6– 0.9 cm.

These forms have sympatric distribution and grow in similar ecological conditions.

At diakinesis, 13 bivalents were invariably counted in the small-leaved form as well (FIGURE 26).

F. glomerata Roxb.

A medium-sized deciduous tree yielding timber of some commercial



FIGURES 4–18. Drawings of chromosome complements. 4 and 5, *Holoptelea integrifolia*: 4, mitotic metaphase, $2n = 28$; 5, M–I, $n = 14$; 6, *Ulmus wallichiana*, somatic metaphase, $2n = 28$; 7, *Celtis cinnamomea*, M–I, $n = 10$; 8, *Artocarpus lakoocha*, M–II, $n = 28$; 9, *Morus alba*, M–I, $n = 14$; 10, *M. laevigata*, M–I, $n = 14$; 11, *Ficus religiosa*, mitotic metaphase, $2n = 26$; 12, *F. glomerata*, mitotic metaphase, $2n = 26$; 13, *F. cunia*, mitotic metaphase, $2n = 26$; 14 and 15, *Broussonetia papyrifera*: 14, diakinesis, $n = 13$; 15, M–I, 10 bivalents and a chain of 6 chromosomes; 16, *Boehmeria rugulosa*, M–I, $n = 28$; 17 and 18, *B. platyphylla*: 17, M–I, $n = 14$; 18, M–I, $n = 28$.

importance. Common in forests at the foot of the Himalayas and its outer ranges up to 1000 m., in moist places, generally along streams. Bark: pale brown, smooth.

FIGURE 12 shows the somatic complement of 26 chromosomes.

Broussonetia Vent.

B. papyrifera (L.) Vent.

A fast growing tree of medium size. Adapted to different ecological conditions, but naturalized in many parts of India. Indigenous to China and Burma.

The chromosome number in individuals from several different localities was found to be $n = 13$ (FIGURE 14). Meiosis was normal in the trees from Dehra Dun, whereas those from the Nainital hills showed chain formation at diakinesis and metaphase-I due to heterozygosity for translocations. A chain of six chromosomes and 10 bivalents was observed in many PMC's (FIGURE 15). Pollen fertility in such individuals was 90–95 per cent. The taxa with and without translocations were morphologically identical.

URTICACEAE

Boehmeria Jacquin.

B. rugulosa Weddell.

A small to medium-sized, evergreen tree, often with short bole. Found in the Himalayan subtropical forests ascending to 1800 m., and common in the Nainital and Mussoorie hills. Wood of some commercial value. Bark: dark brown, rough, furrowed.

Twenty-eight bivalents were counted at metaphase-I (FIGURE 16) in the population studied from different localities in the Nainital and Mussoorie hills. Meiosis was perfectly normal.

B. platyphylla D. Don.

A variable common shrub growing in the subtropical and temperate Himalayas.

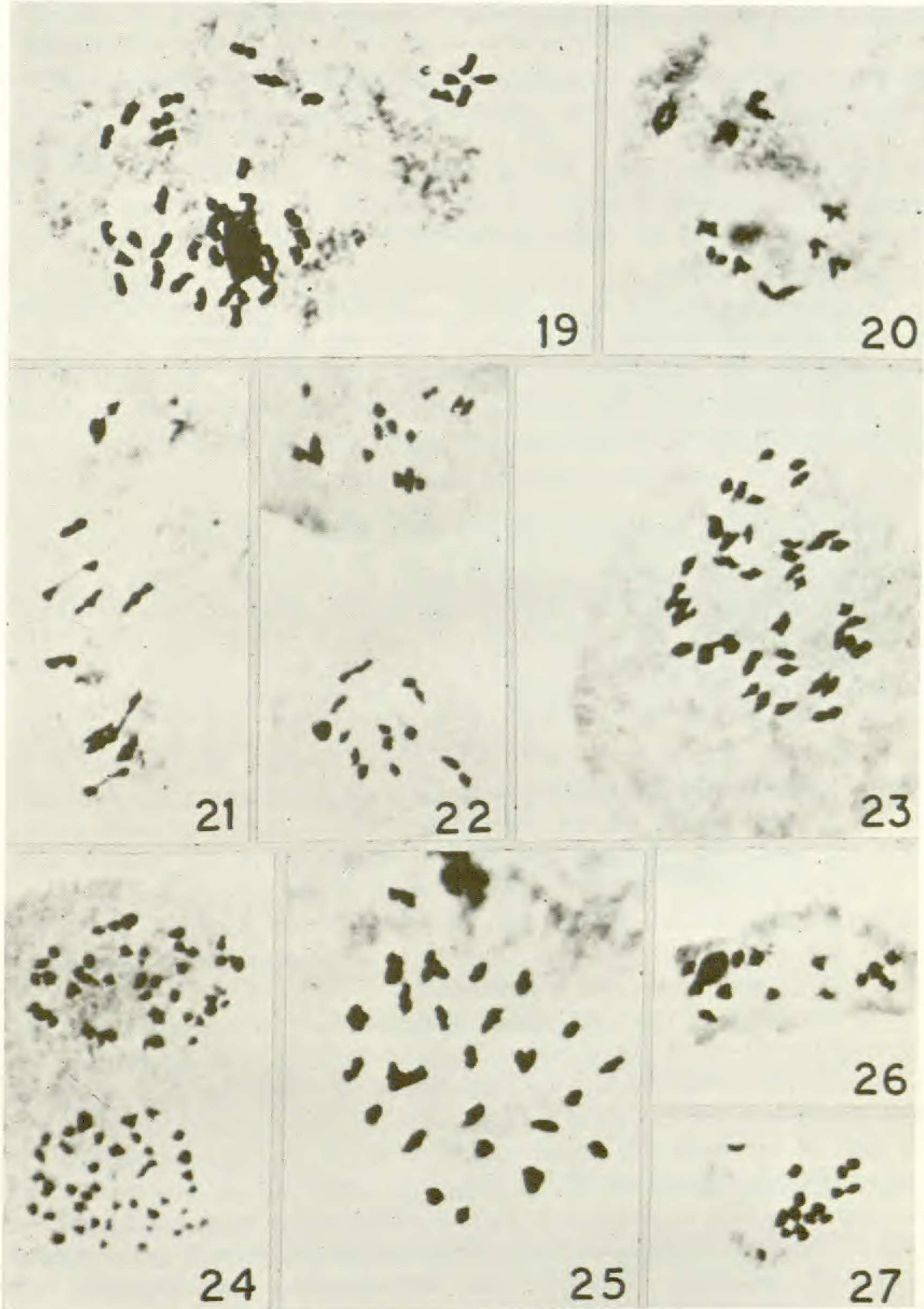
Fourteen bivalents were invariably present in the population from the Mussoorie hills (FIGURE 17), whereas those from the Darjeeling hills were found to have 28 bivalents (FIGURE 18).

DISCUSSION

Of the 22 species presently investigated nine were studied for the first time and new cytotypes for two of these were discovered.

ULMACEAE

Löve and Löve (1961) suggest $x = 7$ as the base number of the genus *Ulmus*, whereas the species of this genus cytologically known up to now, and even those of *Holoptelea* and *Zelkova*, have $n = 14$ or $2n = 28$, except for the intraspecific tetraploid races of *U. americana* and *U. glabra* with $2n = 56$ (Sax, 1933; Santamour, 1969; Ehrenberg, 1949). As such, $x = 14$ seems to be the base number for *Ulmus*, *Holoptelea*, and *Zelkova*, as was proposed by Darlington and Wylie (1955). Like most of the woody taxa, the speciation in these three genera appears to have taken place mostly at the diploid level, rarely involving change in the chromosome number.



FIGURES 19–27. Photomicrographs of chromosome complements. 19, *Celtis australis* var. *australis*, mitotic metaphase, $2n = 40$; 20, *C. australis* var. *eriocarpa*, diakinesis, $n = 10$; 21, *C. tetrandra*, M–I, $n = 10$; 22, *Morus alba*, M–I, $n = 14$; 23, *M. serrata*, M–I, $n = 42$; 24, A–I, $n = 42$; 25, *M. laevigata*, diakinesis, $n = 28$; 26, *Ficus religiosa*, small-leaved, diakinesis, $n = 13$; 27, *Debregeasia hypoleuca*, M–I, $n = 14$.

In *Celtis* and *Trema*, on the other hand, numerical changes in the basic set have been among the factors involved in the evolution of the species. Besides $n = 10$ or $2n = 20$ in several members of the genus *Celtis*, including the presently studied ones, $2n = 22$ was counted in *C. spinosa* (Covas & Schnack, 1947), $n = 13$ in *C. nervosum* (Chuang *et al.*, 1963), $2n = 28$ in *C. occidentalis* (Sax, 1933), and $2n = 40$ in *C. australis* (Bowden, 1945; the present investigations). The prevalence of $n = 10$, which is also the lowest existing haploid number in *Celtis*, suggests the original base number of the genus is $x = 10$, which is also shared by the closely allied genus *Trema* (Hans, 1971).

The present counts of $n = 10$ and $2n = 40$ in the Himalayan populations of *Celtis australis* confirm the report of $2n = 40$ by Bowden (1945) and also establish the existence of intraspecific polyploidy. The tetraploid ($2n = 40$) differs from the diploid ($n = 10$) in having glabrous to pilose drupes, in contrast to the pubescent to woolly ones in the latter.

MORACEAE

The chromosome numbers of the presently studied taxa of Moraceae are based either on $x = 13$ or $x = 14$, which are the prevalent base numbers in the family. Polyploidy seems to have played some evolutionary role in the genera *Ficus*, *Morus*, and *Artocarpus*. Six cases of interspecific polyploidy are recorded in *Ficus* and there are four species which show intraspecific polyploidy (Condit, 1964; Pancho, 1966). In the genus *Morus*, *M. cathayana* with $2n = 56, 84, 112$ (Janaki-Ammal, 1948), and *M. nigra* with $2n = 89$–106 (Voltattorni, 1947) and 308 (Thomas, in Darlington & Wylie, 1955) are the outstanding instances of high intraspecific polyploids. In *M. serrata*, Janaki-Ammal (1948) observed a diploid somatic count, $2n = 28$, while the Nainital and Simla populations of the species with $n = 42$ are hexaploid. *M. laevigata* is another Indian species possessing intraspecific polyploids, a diploid with $2n = 28$ (Janaki-Ammal, 1948; Das, 1961) and a tetraploid with $n = 28$ or $2n = 56$ (Datta, 1954; Das, 1961; Hans, 1972; and the present investigations).

The tetraploid *A. lakoocha* and *A. heterophyllus*, with $n = 28$, and the hexaploid cytotype of *Morus serrata* have perfectly normal meiosis.

Meiotic abnormalities in some populations of *Broussonetia papyrifera*, which is diploid, are obviously a consequence of chromosomal interchanges. In spite of the small size of chromosomes, up to six chromosomes are involved in chain formation. Mehra and Hans (unpublished) observed a ring or chain involving as many as 16 chromosomes and an even smaller second ring in the East Himalayan taxon. The species grows well under varied ecological conditions. Whether these translocations have imparted any selective value for a particular environment is hard to suggest.

URTICACEAE

Darlington and Wylie (1955), and Löve and Löve (1961) proposed $x = 7$ as one of the base numbers for the genus *Boehmeria*. On this basis *B. rugulosa* and the cytotype of *B. platyphylla* from the Eastern Himalayas with $n = 28$ are octoploid, while the West Himalayan taxon of *B. platyphylla* with $n = 14$ is tetraploid. These polyploids, however, are perfectly balanced.

Out of the 25 taxa of the families investigated presently, seven are polyploids. Thus the percentage of polyploidy is 28 per cent in these woody elements.

SUMMARY

Cytological studies on 22 West Himalayan woody species belonging to Ulmaceae, Moraceae, and Urticaceae have been carried out. Of these, the commercial timbers are *Holoptelea integrifolia* ($n = 14$, $2n = 28$), *Ulmus wallichiana* ($2n = 28$), *Celtis australis* ($n = 10$, $2n = 40$) (Ulmaceae); *Artocarpus lakoocha* ($n = 28$), *Morus alba* ($n = 14$), *M. serrata* ($n = 42$), *M. laevigata* ($n = 14$, 28), *Ficus religiosa* ($n = 13$, $2n = 26$), *F. glomerata* ($2n = 26$) (Moraceae), and *Boehmeria rugulosa* ($n = 28$) (Urticaceae). The taxa of *Broussonetia papyrifera* ($n = 13$) with and without chromosomal interchanges are morphologically identical. Morphological forms of *Ficus religiosa* which differ in leaf and fig size have sympatric distribution and the same chromosome number $n = 13$. Intraspecific polyploidy in *Celtis australis* ($2x$, $4x$) and *Boehmeria platyphylla* ($4x$, $8x$) have been recorded here for the first time. Polyploidy seems to have played some role in *Artocarpus, Morus*, and *Ficus*, whereas in *Ulmus* and *Holoptelea* speciation has occurred at the diploid level.

ACKNOWLEDGMENTS

We are sincerely thankful to the sponsoring authorities of the U.S. Government for financial help to the senior author under PL 480, grant A7–FS–12.

LITERATURE CITED

BANERJI, I., & A. HAKIM. 1954. A contribution to the life-history of *Artocarpus lakoocha* Roxb. Proc. Indian Acad. Sci. B. **39**: 128–132.

BOWDEN, W. M. 1940. Diploidy, polyploidy and winter hardiness relationships in the flowering plants. Am. Jour. Bot. **27**: 357–371.

———. 1945. A list of chromosome numbers in higher plants I. Acanthaceae to Myrtaceae. *Ibid.* **32**: 81–92.

BURNHAM, C. R. 1956. Chromosomal interchanges in plants. Bot. Rev. **22**: 419–552.

CAPOOR, S. P. 1937. The life history of *Holoptelea integrifolia* Planch. (Ulmaceae). Beih. Bot. Centralbl. **57**: 233–249.

CHUANG, T. I., C. Y. CHAO, W. W. L. HU, & S. C. KWAN. 1963. Chromosome numbers of the vascular plants of Taiwan I. Taiwania **1**: 51–56.

CONDIT, I. J. 1928. Cytological and morphological studies in the genus *Ficus* I. Chromosome numbers and morphology in seven species. Univ. Calif. Publ. Bot. **11**: 233–244.

———. 1933. Cytological and morphological studies in the genus *Ficus* II. Chromosome numbers and morphology in 31 species. *Ibid.* **17**: 61–74.

———. 1964. Cytological studies in the genus *Ficus* III. Chromosome numbers in sixty-two species. Madroño **17**: 153–155.

COVAS, G., & B. SCHNACK. 1947. Estudios cariologicos en Antofitas. II. Revista Argent. Agron. **14**: 224–231.

DARLINGTON, C. D., & A. P. WYLIE. 1955. Chromosome atlas of flowering plants. George Allen & Unwin Ltd., London.

DAS, B. C. 1961. Cytological studies on *Morus indica* L. and *Morus laevigata* Wall. Caryologia **14**: 159–162.

DATTA, M. 1954. Cytogenetical studies on two species of *Morus*. Cytologia **19**: 86–95.

DELAY, C. 1947. Recherches sur la structure des noyaux quiescent chez les phanerogames. Revue Cytol. Cytophys. Vég. **9**: 169–223; **10**: 103–229.

GAJAPATHY, C. 1961. Cytological studies in some Indian medicinal plants. Bull. Bot. Surv. India **3**: 49–51.

HANS, A. S. 1971. Polyploidy in *Trema* (Ulmaceae). Cytologia **36**: 341–345.

——— 1972. Cytomorphology of arborescent Moraceae. Jour. Arnold Arb. **53**: 216–225.

HSU, C. C. 1967. Preliminary chromosome studies on the vascular plants of Taiwan (I). Taiwania No. **13**: 117–130.

JANAKI-AMMAL, E. K. 1948. The origin of the black mulberry. Jour. Roy. Hort. Soc. **53**: 117–120.

LAWRENCE, G. H. M. 1951. Taxonomy of Vascular Plants. xiii + 823 pp. MacMillan Co., New York.

LECOQ, C. 1963. Contribution à l'étude cyto-taxinomique des Moracées et des Urticacées. Rev. Gen. Bot. **70**: 385–426.

LÖVE, A., & D. LÖVE. 1961. Chromosome numbers of central and northwest European plant species. Opera Botanica **5**: 1–581.

MEHRA, P. N., & A. S. HANS. 1969. *In* IOPB Chromosome number reports XXI. Taxon **18**: 312–315.

——— & B. S. GILL. 1968. *In* IOPB Chromosome number reports. XIX. Taxon **17**(5): 574–576.

MITRA, K., & N. DATTA. 1967. *In* IOPB chromosome number reports XIII. Taxon **16**: 445–461.

NANDA, P. C. 1962. Chromosome numbers of some trees and shrubs. Jour. Indian Bot. Soc. **41**: 271–277.

OSAWA, J. 1920. Cytological and experimental studies in *Morus* with special reference to triploid mutants. Bull. Imp. Agric. Exp. Sta. Tokyo **1**: 318.

PANCHO, J. V. 1966. *In* IOPB chromosome number reports VII. Taxon **15**: 155–163.

PEARSON, R. S., & H. P. BROWN. 1932. Commercial Timbers of India. Vol. II. Govt. of India, Central Publ. Branch, Calcutta.

RADZHABLY, E. P. 1962. Experimental polyploidy in the genus *Morus*. In "Plant Polyploidy." Trud. Mosk. Obsnchest. Ispyt. Prirod. **5**: 360–373.

RAO, S. A. M. 1940. Cytology and embryology in *Artocarpus integrifolia*. Jour. Mysore Univ. **1**: 63–73.

SANTAMOUR, F. S., JR. 1969. New chromosome counts in *Ulmus* and *Platanus*. Rhodora **71**: 544–547.

SAX, K. 1933. Chromosome number in *Ulmus* and related genera. Jour. Arnold Arb.**14**: 82–84.

TAHARA, M. 1910. Über die kernteilung bei *Morus*. Bot. Mag. Tokyo **24**: 281–289.

VOLTATTORNI, S. 1940. Contributo alla conoscenza della embriologia del *Morus alba* L. Boll. R. Staz. Sperim. Gelicolt. e Bachicolt. Ascoli Piceno **19**: 56–63.

———. 1947. Cariologia comparata di alcune varietata di *Morus alba* L. Ann. Sperim. Agrar. N.S. **1**: 163–168.

DEPARTMENT OF BOTANY
PANJAB UNIVERSITY
CHANDIGARH (INDIA)

Present address of the junior author:
DEPARTMENT OF BOTANY
PUNJABI UNIVERSITY
PATIALA-4 (INDIA)

INDEX